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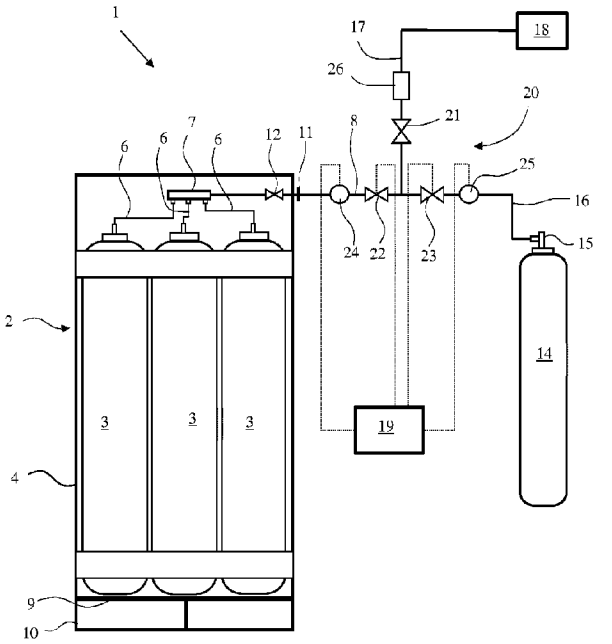

Fig. 1

(57) Abrégé/Abstract:
A device for continuously supplying consumers with gas is equipped with a first withdrawal line, which is connected to a first, exchangeable compressed gas reservoir, and with a second withdrawal line, which is connected to a second, preferably stationary compressed gas reservoir, the two withdrawal lines leading into a common supply line. To ensure that the customer is supplied even during exchange of the first compressed gas reservoir, an automatic switchover device is designed such that, when the pressure falls below a predefined inflow-side pressure value at a shutoff device in the first withdrawal line, said shutoff device closes and a shutoff device in the second withdrawal line opens. According to the invention, the switchover device is also designed such that, after the first compressed gas reservoir is exchanged, the second compressed gas reservoir is automatically filled from the first compressed gas reservoir.

ABSTRACT

A device for continuously supplying consumers with gas is equipped with a first withdrawal line, which is connected to a first, exchangeable compressed gas reservoir, and with a second withdrawal line, which is connected to a second, preferably stationary compressed gas reservoir, the two withdrawal lines leading into a common supply line. To ensure that the customer is supplied even during exchange of the first compressed gas reservoir, an automatic switchover device is designed such that, when the pressure falls below a predefined inflow-side pressure value at a shutoff device in the first withdrawal line, said shutoff device closes and a shutoff device in the second withdrawal line opens. According to the invention, the switchover device is also designed such that, after the first compressed gas reservoir is exchanged, the second compressed gas reservoir is automatically filled from the first compressed gas reservoir.

Date Reçue/Date Received 2022-02-02

Device for continuously supplying a consumer with gas

The invention relates to a device for continuously supplying a consumer with gas, having a first withdrawal line, connected to a first compressed gas reservoir, and a second withdrawal line, connected to a second compressed gas reservoir, which open into a common delivery line, and having a changeover device which is equipped with pressure measuring devices and shutoff devices in the withdrawal lines and is so adapted that, when the pressure at the shutoff device in the first withdrawal line falls below a predefined inflow-side pressure value, the shutoff device closes and the shutoff device in the second withdrawal line opens.

It is known to supply consumers from compressed gas cylinders or compressed gas cylinder bundles. "Compressed gas cylinders" are here to be understood as being compressed gas reservoirs with a filling volume of between 10 liters and 200 liters with a filling pressure of between 150 bar and 300 bar, in which a gas, for example nitrogen, oxygen, carbon dioxide, a noble gas or a gas mixture, in particular a welding gas mixture or a gas mixture intended for food applications, is stored in the gaseous state under pressure. A "compressed gas cylinder bundle", also referred to hereinbelow as a "cylinder bundle", is to be understood as being an arrangement in which a number of compressed gas cylinders, for example from four to twelve compressed gas cylinders, with a filling volume of in each case between 50 liters and 200 liters with a filling pressure of between 150 bar and 300 bar are placed in a frame, which is constructed from frame elements and is mostly open or partially open and can be transported by means of a forklift truck, and are connected to a common withdrawal line. Compressed gas cylinders, cylinder bundles and groups of compressed gas cylinders or cylinder bundles which are coupled together are also subsumed hereinbelow under the term "compressed gas reservoir".

Date Reçue/Date Received 2022-02-02

In compressed gas reservoirs of the mentioned type, there is the problem that the amount of gas available is limited, with the result that an operator, in particular in the case of compressed gas reservoirs from which gas has already been withdrawn, must always check before starting a job that the amount of gas available is sufficient for the intended task. A compressed gas container which still contains a substantial amount of residual gas may have to be exchanged for a full compressed gas container, which incurs costs.

In order to overcome this disadvantage and be able to ensure a continuous gas supply, it is known to group multiple compressed gas cylinders or cylinder bundles together to form "banks of cylinders" or "banks of cylinder bundles". Such a bank consists, for example, of two cylinder bundles or of two groups of cylinder bundles coupled with one another, which are each equipped with a withdrawal line, wherein the withdrawal lines of the two cylinder bundles (or of the two groups of cylinder bundles) open at a junction into a common delivery line. Before or at the junction there is provided a changeover device - this is generally in the form of two shutoff devices or in the form of a three- or four-way valve - which serves to change from one withdrawal line to the other withdrawal line. Thus, for example, if the cylinder bundle that is connected to the first withdrawal line has been emptied to such an extent that further withdrawal of the gas stored therein is no longer possible or expedient, a change is made by means of the changeover device to the second withdrawal line and thus to the second cylinder bundle. The residual or primary pressure of the emptied withdrawal side or the desired supply pressure can be used as the determining changeover parameter. The changeover can take place manually or in an automated manner. Supply then takes place from the second cylinder bundle, while the first cylinder bundle can be uncoupled from the system and exchanged for a full

Date Reçue/Date Received 2022-02-02

cylinder bundle. By alternately exchanging the two cylinder bundles for in each case a full cylinder bundle, a continuous gas supply is thus possible.

Banks of cylinders of the type mentioned above are known, for example, from DE 1 501 703 A1 or DE 10 2006 002 271 A1. DE 19 60 448 A discloses a similar arrangement, suitable in particular for camping purposes, of two gas cylinders which are each equipped with pressure controllers which are set for different withdrawal pressures.

The technology of banks of cylinders has undergone a constant improvement over time. Thus, for example, by means of so-called gas non-return valves as are described, for example, in DE 10 2007 051 927 A1, it is possible to prevent gas from the compressed gas reservoir at a higher pressure from entering the compressed gas reservoir at a lower pressure.

The known systems have proved successful but take up a considerable amount of space, which not all customers have available, and are additionally associated with not inconsiderable investment costs. Moreover, the fill level on both sides must regularly be checked, and cylinders or bundles must regularly be exchanged.

Accordingly, the object underlying the invention is to provide a system for supplying gas which permits a continuous gas supply and which overcomes the disadvantages of the prior art.

This object is achieved in a device of the type and for the purpose mentioned at the beginning in that the changeover device is so adapted that, if a pressure value is present on the inflow side at the shutoff device in the first withdrawal line that is above the inflow-side pressure at the shutoff device in the second withdrawal

line, a flow connection to the second compressed gas reservoir is established.

The device according to the invention thus has two withdrawal lines, to each of which a compressed gas reservoir can be connected. The changeover device comprises shutoff devices in both withdrawal lines and, at least on the inflow side, pressure measuring devices installed upstream of the shutoff devices, as well as a controller by means of which the shutoff devices are operated automatically in dependence on the pressures measured in the withdrawal lines. If both compressed gas containers are connected and full, only the shutoff device in the first withdrawal line - in a manner known *per se* - is open, and the withdrawal of gas takes place only from the first compressed gas reservoir. As soon as the pressure in the first compressed gas reservoir falls below a predefined pressure value, for example when there is only a low residual pressure in the first compressed gas reservoir, or the pressure in the first compressed gas reservoir is below a predefined supply pressure for the consumer, the shutoff device in the first withdrawal line closes preferably automatically and the shutoff device in the second withdrawal line opens; the supply of gas then takes place solely from the second compressed gas reservoir, and the first compressed gas reservoir can then be disconnected from the first withdrawal line and exchanged for a full compressed gas reservoir.

After the full compressed gas reservoir has been connected to the first withdrawal line, the inflow-side pressure at the shutoff device in the first withdrawal line exceeds the inflow-side pressure at the shutoff device in the second withdrawal line. The "inflow side" is here to be understood as being the side of the shutoff valve that is remote from the opening of the corresponding withdrawal line into the common delivery line. On account of the configuration according to the invention of the changeover device, a flow connection

from the first to the second compressed gas reservoir is then established. This takes place, for example, in that the shutoff device in the first withdrawal line and the shutoff device in the second withdrawal line open at the same time. The second compressed gas reservoir is then filled from the first compressed gas reservoir by overflow until pressure equalization between the compressed gas reservoirs or at least a predefined pressure value in the second compressed gas reservoir is reached. The shutoff device in the second withdrawal line is then closed and is opened only when the pressure value in the first compressed gas reservoir again falls below the predefined pressure value as the consumer is supplied with gas.

During the refilling of the second compressed gas reservoir from the first compressed gas reservoir, the common delivery line is preferably open, that is to say the consumer is continuously supplied with gas.

It is thus not necessary according to the invention to disconnect the second compressed gas reservoir from the second withdrawal line after use and replace it with a full compressed gas reservoir. For continuously supplying the consumer, only the first compressed gas reservoir has to be exchanged; the second compressed gas reservoir remains at the customer's premises. This reduces the outlay in terms of monitoring and logistics.

A gas non-return valve, which prevents gas from the full compressed gas reservoir from undesirably passing into the empty compressed gas reservoir, can be provided at least in the first withdrawal line. A gas non-return valve can likewise be fitted in the second withdrawal line, for example in the case that the second compressed gas reservoir is refilled only to a filling pressure that is lower than the maximum filling pressure in the first compressed gas reservoir. In this case, the shutoff device in the second withdrawal line comprises a separate

line (bypass line), which allows the second compressed gas reservoir to be filled and is equipped with a control valve, which ensures that the filling operation is uniform and does not take place too vigorously. This bypass line is closed by means of a valve as soon as the filling operation is complete and/or it is in turn equipped with a backflow preventer, which prevents gas from flowing back once the filling operation is complete.

The changeover device is preferably so adapted that the flow connection from the first to the second compressed gas reservoir closes if the inflow-side pressure at the shutoff device in the second withdrawal line exceeds a predefined value, which is so chosen that the amount of gas present in the second compressed gas reservoir is sufficient to ensure that the consumer is supplied with gas for a certain time, for example between 15 min and 120 min. However, the flow connection to the second compressed gas reservoir should be closed at the latest when there is at least approximately pressure equalization between the two compressed gas reservoirs, measured by the inflow-side pressure at the shutoff device in the first withdrawal line and the inflow-side pressure at the shutoff device in the second withdrawal line.

There is expediently provided as the first compressed gas reservoir a receptacle or a plurality of receptacles which is/are easy to transport and easy to exchange. For example, it is a compressed gas cylinder, a cylinder bundle or a plurality of compressed gas cylinders or cylinder bundles. Since only a comparatively short period of time is required to exchange the first compressed gas reservoir, the volume of the second compressed gas reservoir can be chosen to be very much smaller than that of the first compressed gas reservoir. For example, the second compressed gas reservoir has a maximum of only one tenth, preferably a maximum of only one twentieth, of the volume of the first compressed gas reservoir. As a

result, the pressure loss after exchange of the first compressed gas reservoir owing to the refilling of the second compressed gas reservoir from the exchanged first compressed gas reservoir is kept within narrow limits.

The second compressed gas reservoir, which functions as a buffer container, is preferably a compressed gas cylinder or a comparable pressure container with a volume of, for example, between 10 liters and 50 liters. The second compressed gas reservoir expediently remains permanently, that is to say during and after exchange of the first compressed gas reservoir, on site and connected to the second withdrawal line.

An exemplary embodiment of the invention will be explained in greater detail with reference to the drawing. The single figure (fig. 1) shows, in diagrammatic form, the structure of a device according to the invention.

The device 1 comprises as the first compressed gas reservoir a cylinder bundle 2 of, for example, six, eight, nine, twelve, sixteen or eighteen compressed gas cylinders 3, which is housed inside a frame 4. The cylinders 3 are connected by means of pipe or hose connections 6, via a manifold 7, to a withdrawal line 8. The frame 4 is preferably an open welded structure of steel profiles and comprises in a manner conventional *per se* a base 9 and a transport section 10 which is arranged beneath the base and is intended in particular for the engagement of forklift forks. The withdrawal line 8, which extends transversely through the frame 4, is equipped with a connection piece 11, for example a flange or a thread, at which the cylinder bundle 2 can be disconnected in a simple manner from the remainder of the device 1. A shutoff valve 12 is arranged in the withdrawal line 8. In a manner not shown here, further cylinder bundles, which together with the cylinder bundle 2 form the first compressed gas reservoir within the meaning of

the present invention, can additionally be connected to the withdrawal line 8.

As the second compressed gas reservoir, the device 1 in the exemplary embodiment has a conventional compressed gas cylinder 14. The compressed gas cylinder 14 is equipped with a withdrawal valve 15, to which a withdrawal line 16 is connected. The withdrawal lines 8, 16 open into a common delivery line 17, which establishes a flow connection with a consumer 18.

The device 1 further has a changeover device 20, which, in addition to a control unit 19, which can moreover also be provided in a spatially remote control station, comprises multiple shutoff devices 21, 22, 23 and pressure measuring devices 24, 25, such as, for example, manometers, in the delivery line 17 (shutoff device 21), in the withdrawal line 8 (shutoff device 22 and pressure measuring device 24) and in the withdrawal line 16 (shutoff device 23 and pressure measuring device 25). Furthermore, the changeover device 20 can comprise further devices not shown here, such as, for example, sensors, transmitters, etc., with which further physical or chemical parameters, such as, for example, the ambient temperature, can be taken into account in the control unit 19 or wireless transmission of information to or from the control unit 19 can be established.

By means of the changeover device 20, the withdrawal of gas from the compressed gas reservoirs 2, 14 is controlled automatically in the manner described hereinbelow in dependence on pressures which are measured at the pressure measuring devices 24, 25.

At the start, the cylinder bundle 2 and the compressed gas cylinder 14 are full and the shutoff valve 12 and the withdrawal valve 15 are open. In a first operating state, the shutoff device 22 is open and the shutoff device 23 is closed. By opening the shutoff device 21, the consumer

18 is supplied with gas from the cylinder bundle 2, wherein a pressure maintenance device 26 ensures that a predefined pressure is maintained in the delivery line 17.

As the gas is withdrawn, the pressure in the cylinder bundle 2, measured at the pressure measuring device 24, falls below a predefined value, for example a minimum pressure necessary to supply the consumer 18. If the pressure in the cylinder bundle 2 falls below this value, the shutoff device 22 is closed and the shutoff device 23 is opened. The consumer 18 is then supplied from the compressed gas cylinder 14.

Meanwhile, the shutoff valve 12 is closed, the cylinder bundle 2 is uncoupled from the remainder of the device 1 at the connection piece 11 and removed, and a full cylinder bundle is connected to the connection piece 11 in its place. After the shutoff valve 12 of the exchanged cylinder bundle has been opened, the pressure at the pressure measuring device 24 is greater than the pressure at the pressure measuring device 25, which at the same time corresponds to the pressure in the compressed gas cylinder 14.

The shutoff device 22 is then opened, the shutoff device 23 remains open (or a flow connection *via* a bypass line, not shown here, opens) and the gas flows from the exchanged cylinder bundle 2 both to the consumer 18 and into the compressed gas cylinder 14.

As soon as the compressed gas cylinder 14 is full, that is to say as soon as a predefined pressure value is reached and/or the pressure values measured at the pressure measuring devices 24, 25 are substantially equal, the shutoff device 23 is closed and the gas again flows to the consumer 18 solely from the cylinder bundle 2.

During operation of the device 1, the consumer 18 is supplied almost entirely from the cylinder bundle 2; only during the comparatively short time in which the cylinder bundle 2 has to be exchanged does the compressed gas cylinder 14, which in this respect functions as a buffer container, take over the supply. This compressed gas cylinder can therefore have a considerably smaller filling volume than the cylinder bundle 2 and can remain permanently on site.

List of reference numerals

1. device
2. cylinder bundle
3. compressed gas cylinder
4. frame
5. -
6. connections
7. manifold
8. withdrawal line
9. base
10. transport section
11. connection piece
12. shutoff valve
13. -
14. compressed gas cylinder
15. withdrawal valve
16. withdrawal line
17. delivery line
18. consumer
19. control unit
20. changeover device
21. shutoff device
22. shutoff device
23. shutoff device
24. pressure measuring device
25. pressure measuring device
26. pressure maintenance device

Patent claims

1. A device for continuously supplying a consumer with gas, having a first withdrawal line (8), connected to a first compressed gas reservoir (2), and a second withdrawal line (16), connected to a second compressed gas reservoir (14), which open into a common delivery line (17), and having a changeover device (20) which is equipped with pressure measuring devices (24, 25) and shutoff devices (22, 23) in the withdrawal lines (8, 16) and is so adapted that, when the pressure at the shutoff device (22) in the first withdrawal line (8) falls below a predefined inflow-side pressure value, the shutoff device (22) closes and the shutoff device (23) in the second withdrawal line (16) opens,
characterized in that
the changeover device (20) is so adapted that, if a pressure value is present on the inflow side at the shutoff device (22) in the first withdrawal line (8) that is above the inflow-side pressure at the shutoff device (23) in the second withdrawal line (16), a flow connection is established between the first compressed gas reservoir (2) and the second compressed gas reservoir (14).

2. The device as claimed in claim 1, characterized in that the changeover device (20) is so adapted that the flow connection to the second compressed gas reservoir (14) closes if the inflow-side pressure at the shutoff device (23) in the second withdrawal line (16) exceeds a predefined value.

3. The device as claimed in claim 2, characterized in that the flow connection to the second compressed gas reservoir (14) closes if there is at least approximately pressure equalization between the inflow-side pressure at the shutoff device (22) in the first withdrawal line (8) and the inflow-side

Date Reçue/Date Received 2022-02-02

pressure at the shutoff device (23) in the second withdrawal line (16).

4. The device as claimed in one of the preceding claims, characterized in that there is provided as the first compressed gas reservoir (2) a compressed gas cylinder, a cylinder bundle or a plurality of compressed gas cylinders or cylinder bundles.

5. The device as claimed in one of the preceding claims, characterized in that the filling volume of the second compressed gas reservoir (14) is a maximum of one tenth, preferably a maximum of one twentieth, of the filling volume of the first compressed gas reservoir (2).

6. The device as claimed in one of the preceding claims, characterized in that a compressed gas cylinder is provided as the second compressed gas reservoir (14).

Date Reçue/Date Received 2022-02-02

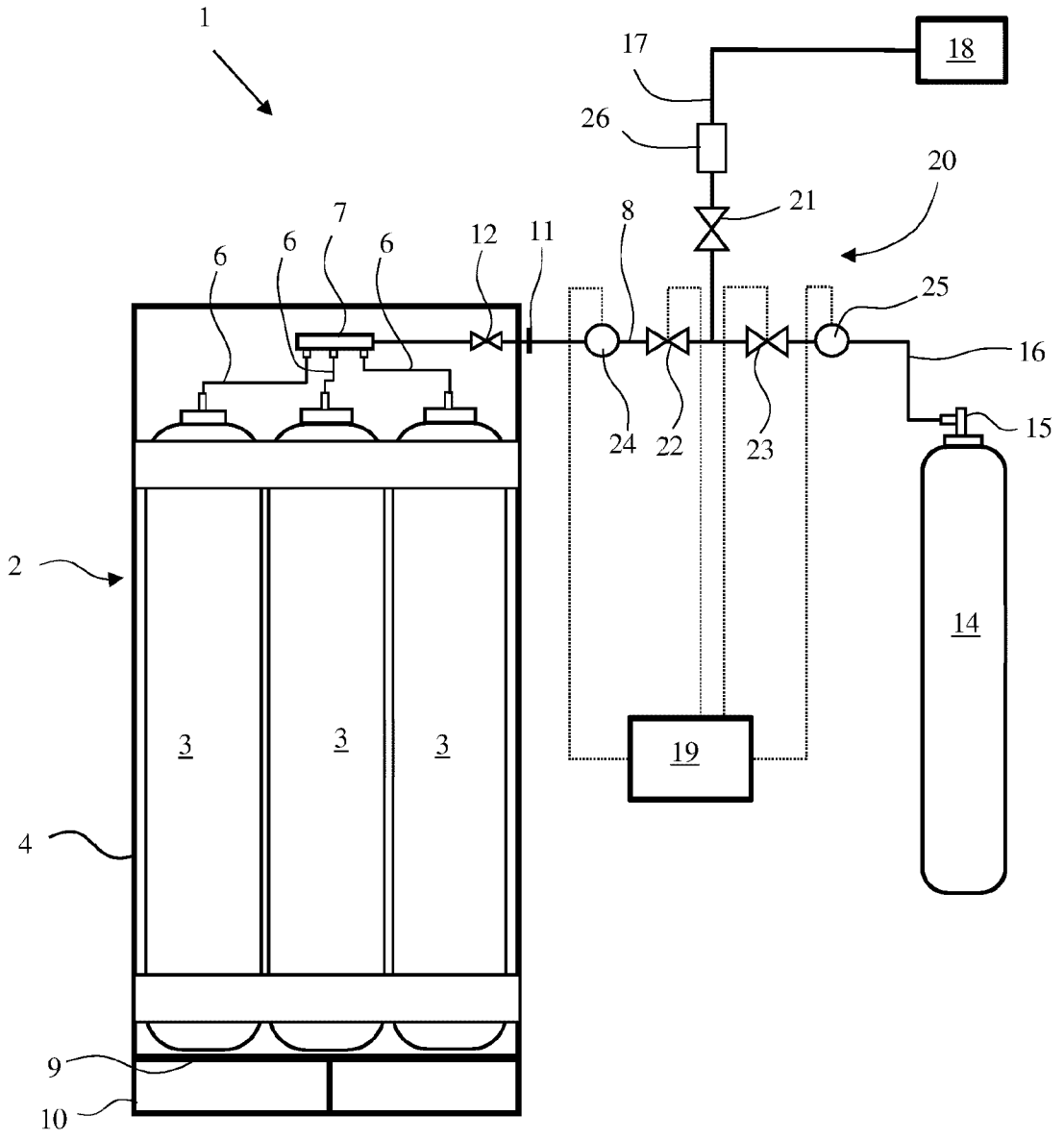

Fig. 1

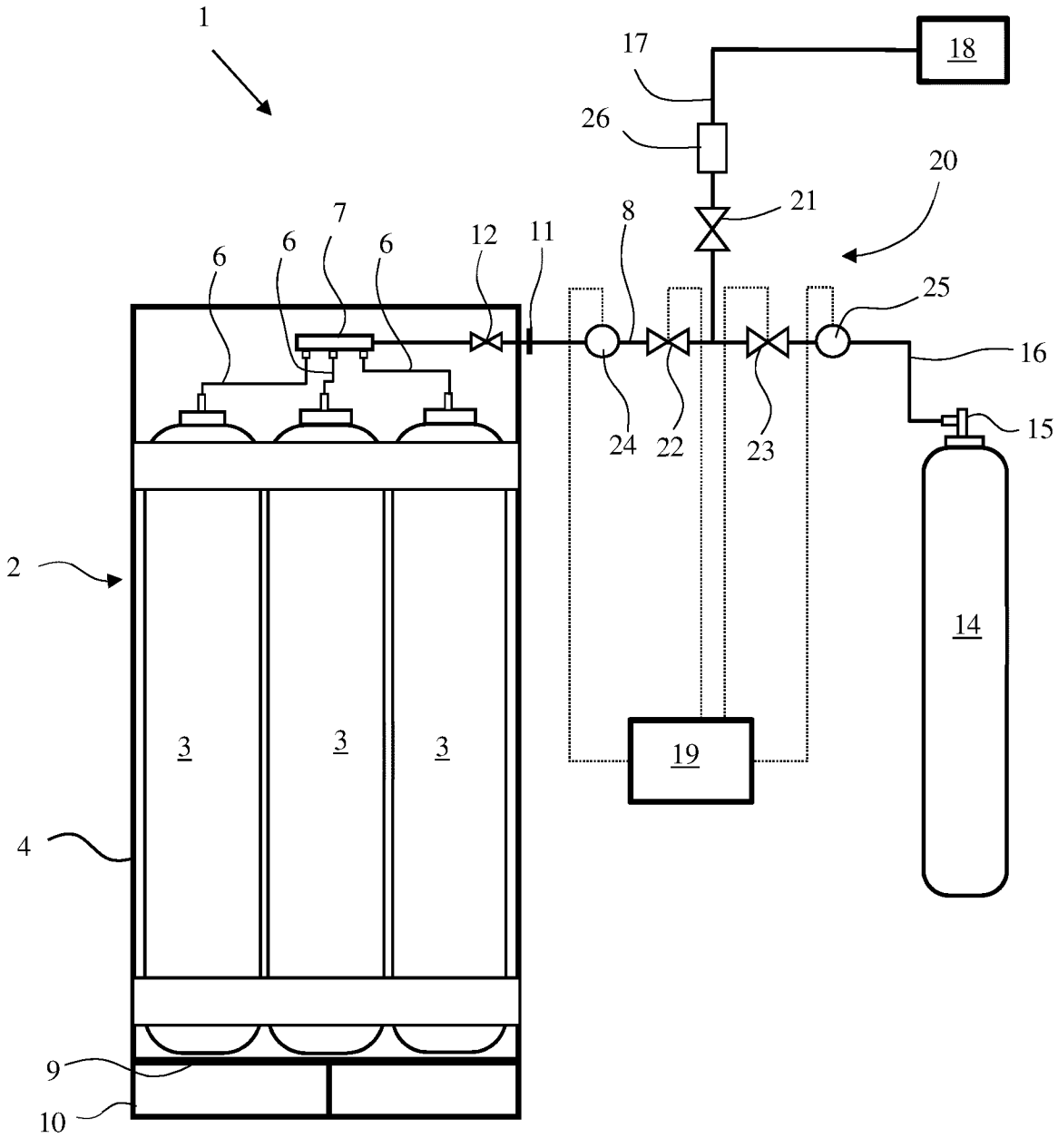

Fig. 1